Volume 39 August, 1953 *Number 8*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

LUBRICATION
OF
CHAIN DRIVES

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

Published by
The Texas Company, 135 East 42nd Street, New York 17, N. Y.

Vol. XXXIX August, 1953 No. 8

LUBRICATION OF CHAIN DRIVES

LEONARDO DA VINCI invented the first chain drive. The modern age of power transmission put it to work. Today it is used wherever power is to be transmitted from one parallel shaft to another. Like any other type of mechanical device the chain drive has developed from earlier, crude ideas, to become an engineering mechanism which is precision manufactured and which offers prolonged life when properly maintained. Wherever power consumption or link protection are factors, the builders of modern chain drives provide oil retaining casings and very often means for automatic lubrication. Chain casings also prevent accidents by reducing the hazard, not only of contact with the moving chain or sprocket, but also slipping on oil or grease drip on the floor.

In addition to their inherent "location" advantages for certain types of power transmission, chain drives possess flexibility, a feature which makes them useful where vibration or shock may be involved. Chain elements are able to take up the destructive effects of this type of service, as it prevails, for example on heavy duty machinery subject to sudden starting and stopping under more or less full load.

TYPES OF CHAINS

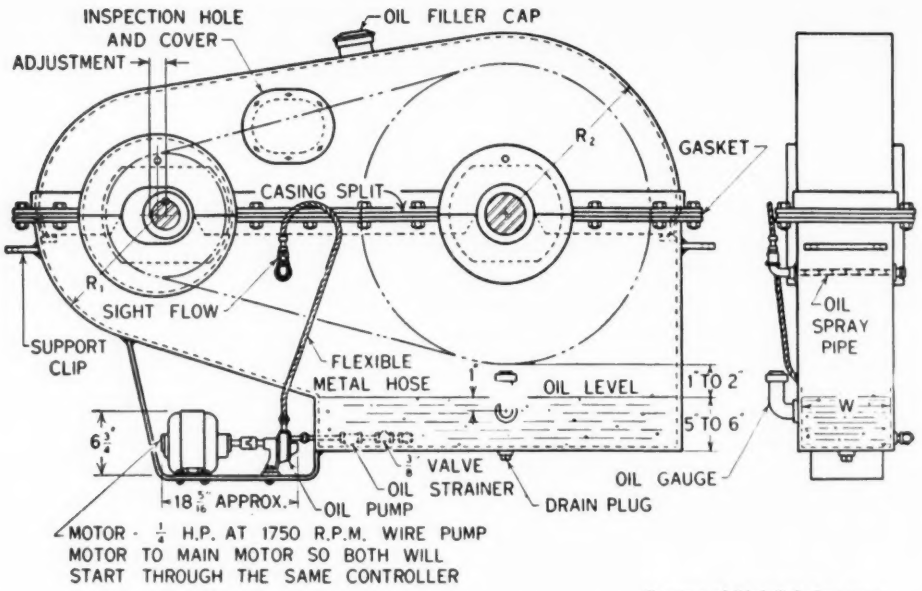
In the course of their development three broad types of chains have resulted. Possibly the speed and type of service had a great deal to do with refinements in design, although the protective benefits of effective lubrication also were actively considered. In the order of this development these types involve

Malleable iron or stamped steel chains
Roller or block type chains, and
Silent or inverted tooth types.

Malleable iron or stamped steel chains generally are used where speed conditions do not exceed 350 to 450 feet per minute. They may be of the open (detachable) or closed (pintle) type according to the way in which the links engage with the pins. The nature of construction of a chain of this type requires lubrication with a comparatively heavy bodied product, and hand application by brushing on is the most prevalent procedure.

Roller or block type chains, however, are considerably more precise in their construction. As such they require, and normally receive, careful attention to lubrication. In chains of this type it is equally as important to study the design of the sprocket teeth as the design of the chain links. They are applicable to oil field service and other operations where the distance between sprocket centers may be upward of several feet. They also are well suited to high speed service, i.e. 3500 to 5000 feet per minute. Properly designed roller chain drives can withstand severe shock loading as well as impulsive loading, because they are less rigid than gears. At the same time they possess an inherent although limited degree of elasticity. These features also make roller chains especially suitable for very low speed service.

A silent or inverted tooth type chain is used to good advantage where a similar range of speeds are involved but where relatively short distances exist



Courtesy of Link-Belt Company

Figure 1 — Layout for a Link-Belt System for force feed lubrication of a chain drive, equipped with an integral oil sump.

between sprocket centers. Within a speed range of 1500 to 6000 feet per minute, such chains have relatively quiet operating characteristics. The nature of the link mechanism in such a chain often requires a somewhat lower viscosity lubricant than would be used on a roller chain.

CHAIN CONSTRUCTION

Detachable Chains

The detachable chain is built up of stamped steel or cast malleable iron links which engage with each other. It is probably the least expensive and simplest type in use today. When such a chain is straightened out the links cannot dissengage, but by folding or bending, the end bar can readily be slipped out from the hook through the aperture in the latter.

Cast detachable chains are used in materials handling for elevator and conveyor service or for sprocket drives where a relatively low-cost durable chain is necessary and speeds do not exceed 350 feet per minute. Due to the usual high clearances involved, chains of this nature are apt to wear rapidly in the presence of dirt, dust and other abrasive materials. Abrasive wear increases the pitch and frequently causes the chain links to fit unevenly over the sprocket teeth. To counteract this the use of a highly adhesive, semi-fluid straight mineral chain lubricant has been found to be beneficial where lubrication is possible. Often however, it is better to run such a chain dry where there is continued contact with abrasives because housings generally are not used.

When cast detachable chains are to be used on sprockets a certain amount of slack may prevail. This can be corrected by using a coupler link built for pin connection. Links of this type can be readily inserted or removed as neccessary.

Pintle Chains

The pintle chain extends the application of the cast malleable iron link to a pin connected device; it is a valuable substitute for the detachable chain when operating in the presence of abrasive materials. The connecting pins are either riveted over on the ends or held rigidly in the links by nuts or cotter pins.

The manner of construction makes pintle chains stronger than detachable chains, consequently the former can be used on somewhat heavier service at speeds up to 450 feet per minute. Variations of this type of chain include the saw mill and interlocking pintle chain. This latter is built with self-contained link connections which are effective in preventing the entry of dirt, dust or other abrasive matter. On the other hand, there is sufficient end clearance to permit of ready entry of a comparatively heavy gear lubricant. Once such a lubricant has penetrated to the interior wearing surfaces, this clearance serves to retain it and prevent dripping or throwing during operation. Lubrication is difficult to maintain however, where either pintle or detachable chains are used as drags in conveyor work, such as in the handling of sawdust, ashes or other fine materials.

Roller Chains

Accuracy, and dependability are features of the roller chain. These advantages are obtained by centerless grinding the round case hardened parts to a tolerance of but a few ten thousands of an inch and heat-treating of the link plates. Machining to precision fit is an aid to subsequent lubrication, and insurance against abnormal wear under comparatively high speed operation. Sprocket teeth also are constructed in the same manner.

The extreme service under which certain oil field chains must operate is an excellent example of what an average roller chain must be capable of enduring. As well, it is an ideal example of how lubrication promotes efficient chain operation. Possibly the chain links will seem to be dirty and coated with a greasy mixture of caked lubricant. This is but a surface indication, however. If a proper chain lubricant has been used, and carefully applied to the chains, in all probability the interior wearing surfaces of the links and rollers, etc., will be practically free from abrasive matter and protected by an adhesive film of the lubricant.

Silent Chain Drives

Silent chains include all such driving mechanisms as are built up of parallel series of links fastened to each other and to the adjoining links by pins and bushings, or seat and rocker pins. This type of construction gives exceptional articulating or bending ability to the entire chain, with very little wear and noise, provided lubrication is properly maintained.

The link or joint connecting device is the distinguishing feature in a silent chain. The design determines the amount and type of lubricant which should be used. Where the working surfaces of the pins are closed, lubricant must penetrate from the ends of the pins under the riveted heads. In some cases a pumping system is required to assure of complete application of oil. On the other hand, where the chain joint is open for the full width of the chain, the pins are exposed to complete lubrication by drip feed or oil mist method.

Sliding friction occurs between the link pins and bushings. These bushings are generally constructed as segments, two being required per joint. The uniformity of the bearing surfaces permits wear to occur evently between the pins and bushings. In operation, chains of this character fold into the sprocket teeth without jar, and each link fits perfectly with the corresponding tooth. If wear occurs radial adjustment is possible in order to compensate for any lengthening of pitch.

Silent chains are retained in proper position on the sprockets and prevented from working off by the use of a center guide, or flanges on each side of the driving sprockets. Normally with properly aligned drives little guiding is necessary, hence the wear on the sides of the guide is slight, especially as guiding takes place on the slack of the chain.

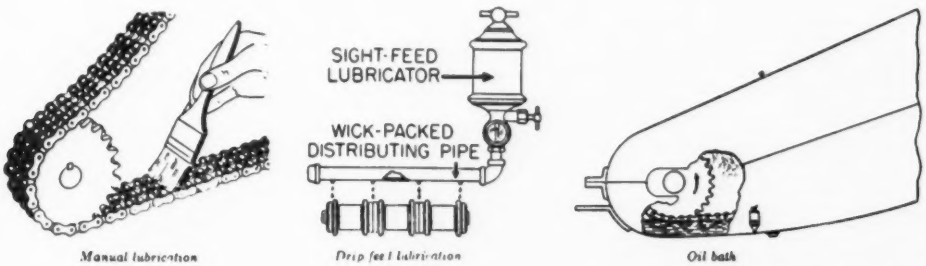
In rocker joint chains rolling friction occurs instead of sliding friction. This is attained by the elimination of bushings and use of two pins, one known as the "seat pin" which is built with a plane or convex surface, the other, termed the "rocker pin" which has a convex surface. By inserting these pins into the links a rocking or rolling effect is attained when bending takes place. In general, the rocker joint type of silent chain is used for higher speed operations since its lower frictional coefficient enables it to function without generating excessive heat.

CONDITIONS AFFECTING CHAIN LUBRICATION

Lubricants for chain drives must be selected according to the service conditions and the type of housing. The service conditions include speed, load, clearances and extent of bending or articulation.

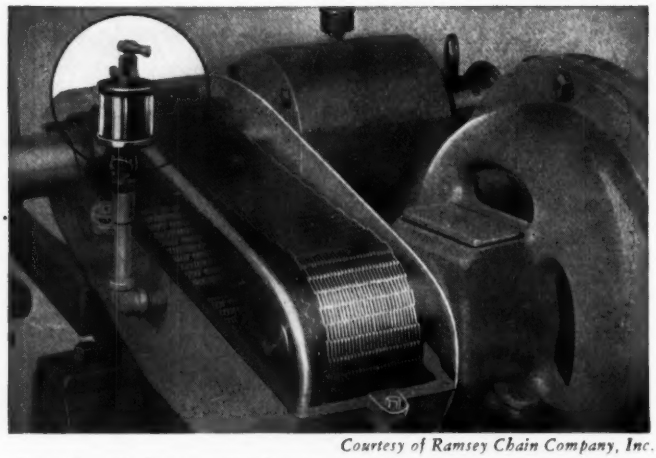
Speed and Load

Speed is important, since it involves the frequency of shocks due to engagement of the chain links with the sprocket teeth. In other words, the greater the speed the more frequent will be the shock on each link. Whether or not shocks of this nature will be detrimental to lubrication will depend



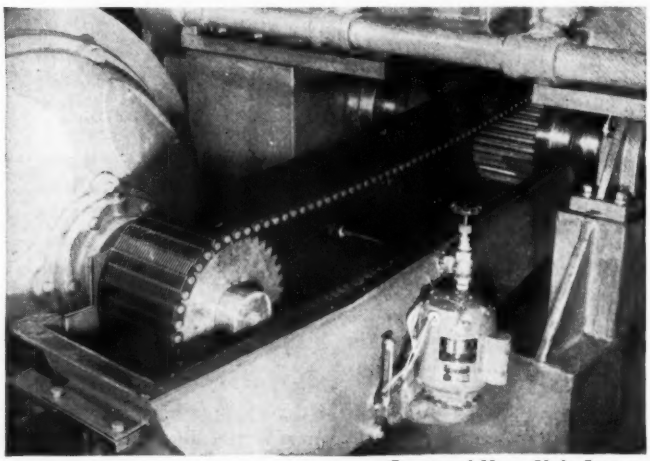
Courtesy of Chain Belt Company

Figure 2 — Showing methods for manual, drip feed and oil bath lubrication as suggested by Chain Belt for Baldwin-Rex roller chains.



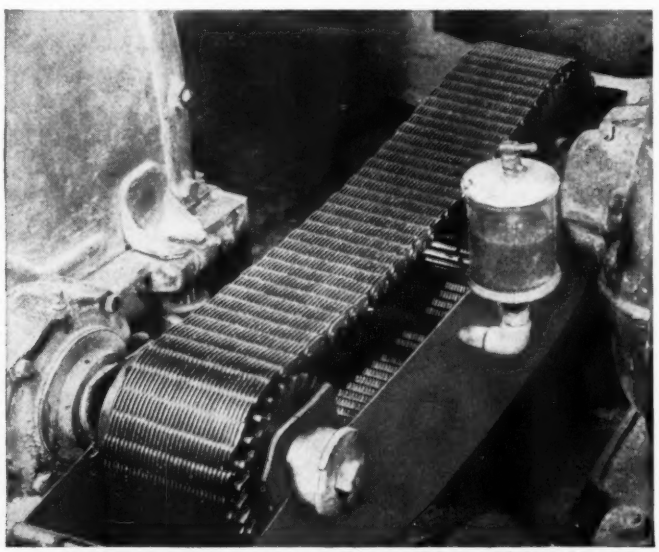
Courtesy of Ramsey Chain Company, Inc.

Figure 3 — The Ramsey roller bearing joint type of silent chain built into an automatic woodworking lathe. Note no oil bath is necessary.



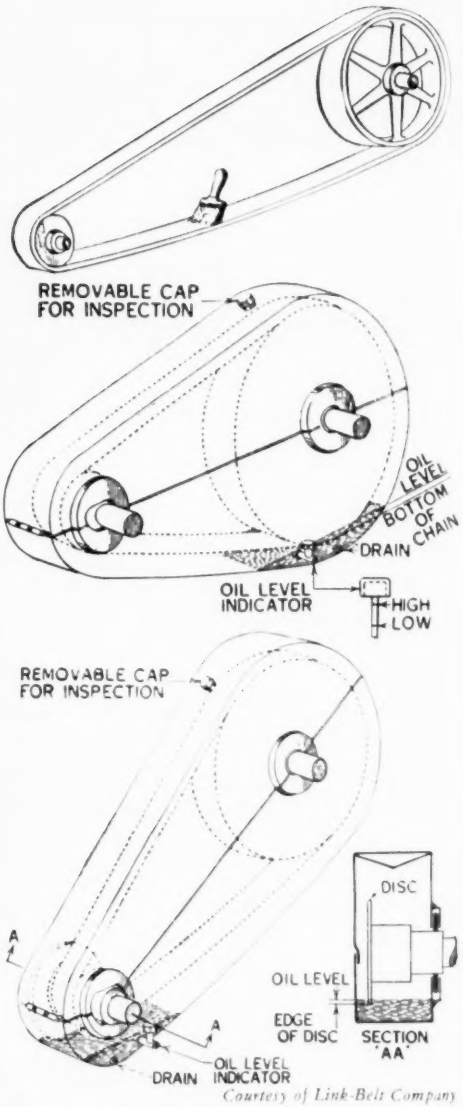
Courtesy of Morse Chain Company Division of Borg-Warner Corp.

Figure 4 — A typical motor driven pump and spray bar assembly used with a Morse Hy-Vo drive. Note pump unit and oil level gauge on side of casing.



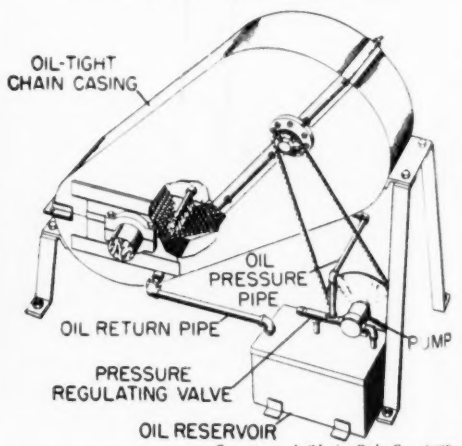
Courtesy of Ramsey Chain Company, Inc.

Figure 5 — A Ramsey chain drive on a hammer mill which grinds wood shavings. Chain attains a velocity of 5030 f.p.m. lubricated only by drip feed from oil cup on the casing.



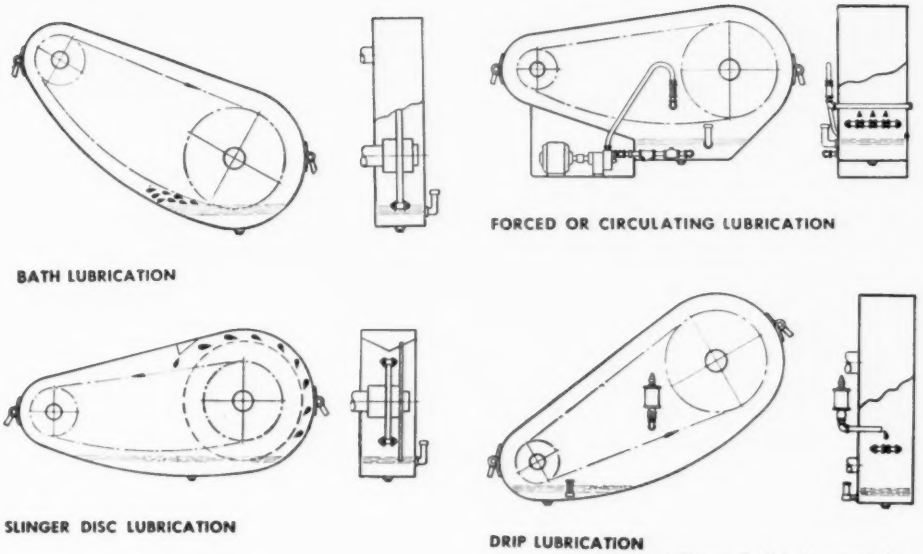
Courtesy of Link-Belt Company

Figure 6 — Three methods of lubrication for chain drives as indicated by Link-Belt. (Top) by brushing; (center) by splash; (and above) by disc.



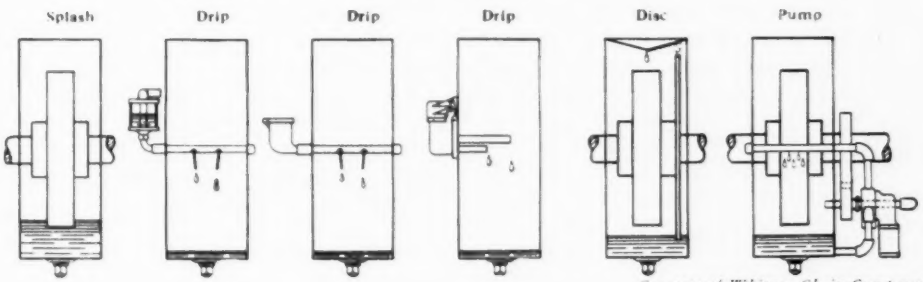
Courtesy of Chain Belt Company

Figure 7 — Details of a Chain Belt arrangement for force feed lubrication of a roller chain.



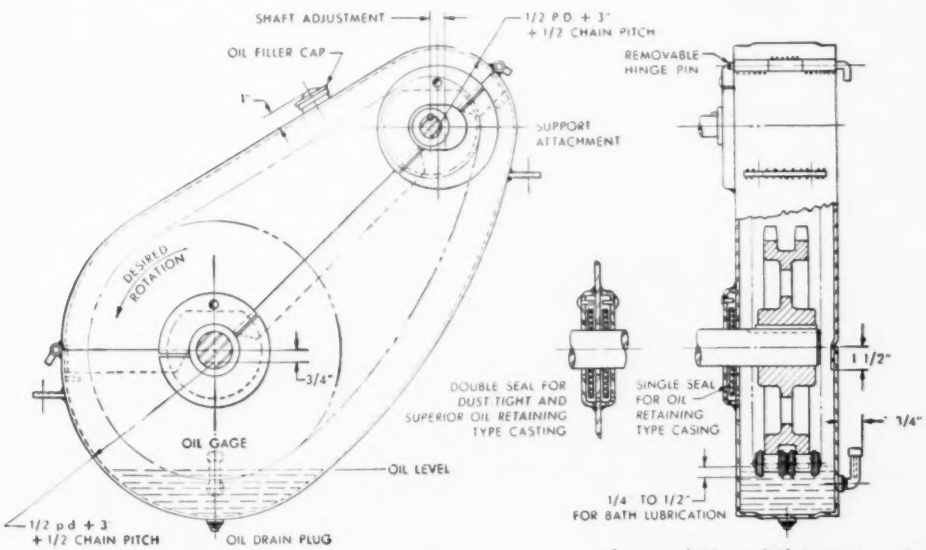
Courtesy of Diamond Chain Company, Inc.

Figure 8 – Methods of lubrication suggested for Diamond roller chains.



Courtesy of Whitney Chain Company

Figure 9 – The Whitney portrayal of methods of lubrication for chain drives.



Courtesy of Diamond Chain Company, Inc.

Figure 10 – Constructional features of a Diamond roller chain casing designed for bath lubrication.

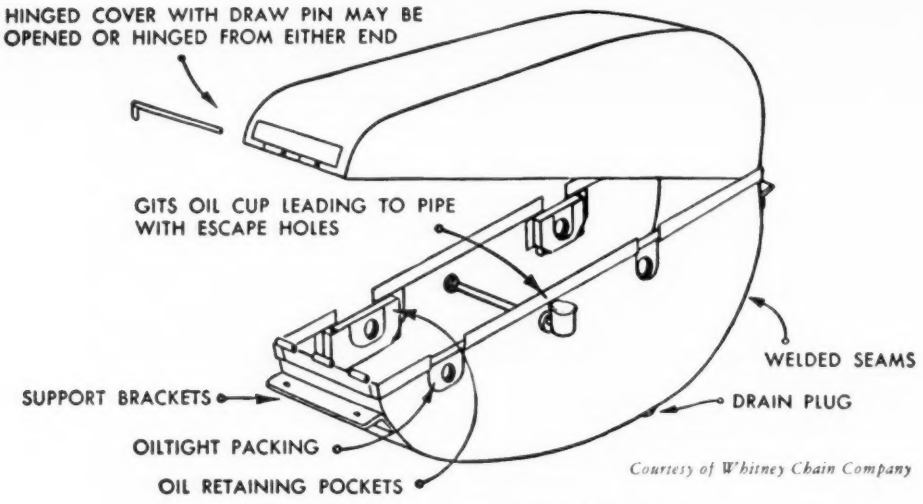


Figure 11 — Details of the Whitney oil retaining casing.

upon the load and constancy of operation. Unless very high loads are involved, generally speaking a re-forming procedure goes on within the oil film between the pins, bushings and other component parts of the chain. Chain authorities agree that a fluid oil at the operating temperature lends itself best to this film re-forming process through capillary action. Conversely increasing the viscosity of the lubricant to any great extent as is sometimes done on heavily loaded bearings would react adversely in a chain link mechanism. It is customary to assume that the standard practice of load reduction with increase in speed will sufficiently reduce link shock to not only keep within the required factor of safety, but as well to insure continuation of effective lubrication.

Effect of Joint Articulation

Bending or articulation of a driving chain imposes wear not only on the link pin bearings, but as well at the points of contact between the chain and the sprocket teeth. In fact, this is the chief cause of external wear, both of the chain and sprocket, notwithstanding that correct chain design endeavors to eliminate as far as possible this tendency towards friction and external wear, confining any necessary rubbing or rolling to the joints.

To this end, pins, bushings, rollers, etc., are customarly built with adequate bearing surface to take up the usual strains. Still, a certain amount of external wear will be present in any case; for this reason an adaptable chain lubricant should be capable of effectively serving both internal and external wearing points.

Clearance and Lubricant Penetration

Depending upon the existing clearances, the lubricant must have adequate fluidity in order to be able to penetrate thoroughly throughout the entire link whether pins and bushings, rollers or rocker joints are involved. On the other hand, detachable or pintle type chains may require a heavier grade of lubricant (than would be used on a roller or silent chain) to enable it to resist the effects of centrifugal force and stick to the wearing surfaces.

When chains must be operated in the presence of dust, dirt, chemical fumes or water, the duty imposed upon the lubricant becomes all the greater. In such cases not only must it serve as a lubricant but also as a protective agent for the pin and link bearing surfaces.

Grit, dust, acids and moisture will promote wear and corrosion to a marked extent. Grit and dust in particular being of an extremely penetrative nature will tend to work into clearance spaces and immediately increase the wear. Unless the lubricant is of the proper viscosity and base, it will often become incorporated with such foreign matter and develop into an abrasive paste similer to a valve grinding compound.

Grease lubrication is practicable under such conditions for some types of chains. It is true that chains with greasy exterior surfaces will pick up dirt and grit, but this is offset by the fact that grease in the clearances seals against entry of abrasive materials. Furthermore the clearances between chain link plates, and between the ends of chains rollers and the inner faces of roller link plates are so very small (being on the order of a very few thousandths of an inch) that edge filtration virtually is developed. Obviously a grease lubricated chain in such service should be cleaned thoroughly at regular intervals.

SELECTION OF LUBRICANTS

The primary requirement of a chain lubricant is that it shall penetrate throughout the clearance spaces of the rollers, rockers or sliding surfaces of the links. It does no good to apply a lubricant to the surface of a chain if it has not the penetrative ability to reach all the wearing parts by virtue of its viscosity and the clearance between these respective parts.

For the Pintle Type

The more simple designs of chains such as the detachable and pintle types, may or may not be lubricated, according to the nature of their service. Wherever possible, however, it will be advisable to attempt to lubricate them, unless they actually operate in contact with an excess of foreign matter; here a lubricant would become more of a detriment than a benefit. For detachable and pintle chains a relatively heavy gear lubricant is often considered to be most effective, although in dusty or dirty conditions chains should be cleaned at periodic intervals to remove accumulations of contaminated lubricant. Otherwise the links might "ride" on the sprocket teeth due to excessive wear and pitch elongation.

For Roller Chains

The modern roller chain is a precision mechanism; as such, its lubrication is always important. When such chains are enclosed, it is comparatively easy to maintain lubrication because means for oil circulation is provided. Normally they can be well protected (according to temperature) by a good quality straight mineral or additive type of motor or industrial oil ranging from 300 to 1500 seconds Saybolt Universal viscosity at 100° F.; chain manufacturers talk in terms of S.A.E. 20 to 50.

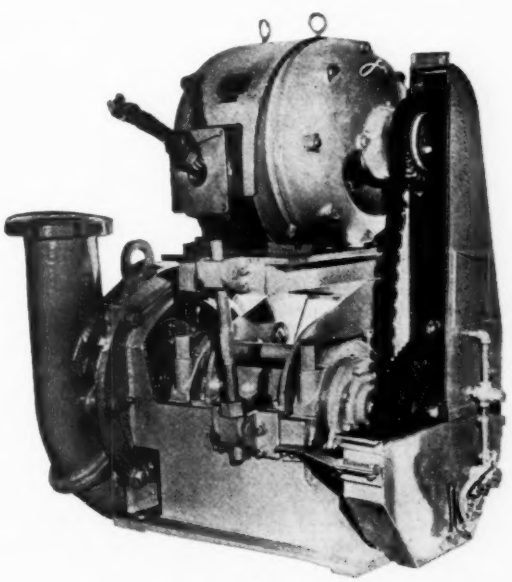
Not all roller chains are enclosed, however, some operate exposed. Then the lubricant can be applied by brushing uniformly over the wearing surfaces while the chain is operating slowly. When heavier gear oils are used in such service to withstand excessive throw-off, it may be necessary to heat them before application to facilitate spreading and penetration.

Oil field roller chains must be most carefully lubricated due to the part they play in the production schedule. As a result, their lubrication requirements have been studied and a wide variety of long-time tests run to determine the protective ability of a variety of prospective lubricants. Experience has indicated that mild E.P. type gear lubricants are quite applicable. The viscosity range is necessarily wide due to the varied means which may be provided for application. Normally, the more fluid products can be applied by drip feed, by hand or used successfully in an automatic self-lubricating system.

For Silent Chains

Silent chains generally are enclosed in a relatively oil-tight casing. The speed of operation is sometimes regarded as a guide as to whether a casing should be used. However, in service where dust, grit or other foreign matter is present, a casing is always advisable whatever the speed. Naturally, a chain which operates in a dust-proof, oil-tight casing which is equipped with some form of automatic lubricator, will function most efficiently and require the least attention.

Due to the fact that clearances in silent chains usually are very small, it is generally advisable to use a relatively fluid lubricant. When chains are encased, if they are to be bath lubricated, a medium bodied product having a viscosity of from 150 to 1500 seconds Saybolt Universal at 100°F. will be suitable. Where exposed, or encased but not submerged in oil, a light gear oil should be used. Considerable difference of opinion often arises as to the use of greases or other semi-solid products. In many cases these would serve the purpose especially on such chains as have sufficient clearance to enable proper penetration. Still it can be appreciated that the lubricant must have a certain ability to flow, and capillary action cannot always be depended upon to



Courtesy of Morse Chain Company Division of Borg-Warner Corp.

Figure 12 — A Morse Hy-Vo chain drive to a motor driven lubricant pump on a dredge pump. Note piping from lubricant pump near bottom of case to spray bar; also the oil level indicator.

bring about suitable penetration to the pins, bushing or rockers, etc.

MAINTAINING LUBRICATION

An effective type of casing chain-lubricator makes use of the principles of splash lubrication by means of a disc attached to one side of the main shaft. As the sprocket wheel rotates the disc dips into the oil in the base and throws it on to a collector plate from which it drains to a gutter for distribution by continuous and uniform dripping upon the inner side of the chain. In casings of this type the oil level is below the chain; the disc dips therein to a depth of one-fourth to one-half inch.

Other types of casings depend upon bath lubrication. Here the oil level should be about half way above the lowest part of the chain.

Casings which are used on high speed chains are often equipped with an oil pump. Forced lubrication is thus attained, the oil being sprayed continually upon the chain.

Certain manufacturers treat their chains with lubricant before they leave the factory in order to give them a good start in life. Roller chain manufacturers use a lubricant containing a rust preventive, to protect the chain parts against rusting or corrosion in transit or storage, and to provide initial lubrication in service. Usually a soaking bath is used, the chains being immersed for a sufficient length of time to allow penetration to all interior parts. Working of the chain in the lubricant is suggested to promote complete penetration. Where a bath of warm lubricant is used, allow the chain to soak long enough to come up to temperature. Controlled heat is important, because overheating could affect the hardness of the chain parts.

When it is impossible to remove a silent chain for such treatment, the bearing or driving surface should be brushed or otherwise treated with a light, uniform coating of lubricant about once a week or more frequently if necessary.

If this is done during slow operation considerable penetration will occur to all the joints through the combined effects of bending and capillary action.

RIGIDITY

Rigidity in many chain installations is an important feature. Bearings therefore must be securely anchored in order to prevent vibration of shafts or the possible shortening of the distance between centers. In making such a roller or silent chain installation the shafts and sprockets should be tested for "levelness"; measurements being taken between shafts on each side of the sprockets in order to bring them directly parallel, then the sprockets are lined up accurately by laying a straight edge across their sides. Alignment should be checked periodically after the chains have been in operation, in order to make any necessary corrections and prevent wear on individual links from becoming serious.

WEAR

The basic reason for chain replacement is mutual wear of pins and bushings, to result in pitch elongation and ultimately improper fit of chains and sprockets. In a well lubricated chain even under very high speeds this rate of wear, as indicated by pitch elongation, is very slow. Sprocket wear in turn can only occur in a well designed drive as a result of chain wear, and except in services where a roller chain is exposed to abrasive dirt or grit, it is not too important to consider lubrication of the external surfaces of the chain.

POWDERED METALS

One of the latest innovations in chain assembly has been the use of sintered metal bushings. The porosity of such materials is an advantage where chains are used on food machinery and in other operations where so-called perishable products are being handled. Oil drip or splash on such products obviously would be harmful. By using a metal structure which is porous and capable of retaining a certain amount of oil, over-lubrication is less apt to occur and yet the chain parts are claimed to be amply protected.

SUMMARY

The modern chain drive is as prominent a feature in power transmission today as the gear train; its lubrication is equally as important. In this development of the chain as a medium for power transmission a number of designs have been perfected according to the service involved and the designers ideas as to link construction. All, however, require constant protection by lubrication. Just as link design may vary according to the manufacturers ideas, so will the preferred methods of lubrication vary. Some chains can be lubricated effectively by drip feed or oil mist; others require pressure circulation of oil. There may also be special cases where a light grease may be desirable. This article has discussed the various types of chain design as related to lubrication, and the methods by which this can be most effectually maintained.

Printed in U. S. A. by
Salley & Collins, Inc.
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TEXACO LUBRICANT RECOMMENDATIONS FOR CHAIN DRIVES

EQUIPMENT	LUBRICANT
1. Malleable Iron or Stamped Steel Chains	
Usually exposed	Texaco Crater or Meropa Lubricants (according to operating conditions and Lubrication Engineer's recommendation)
2. Roller and Block Type Chains	
A) High operating temperature (above 140°F.)	
Worn or subject to dirt, water or chemicals	Texaco Crater 1X or Crater 2X Fluid
Where surroundings are clean or chains are new or enclosed	Texaco Thuban 140 or Meropa Lubricant 6
B) Medium operating temperature (32 to 140°F.)	
Worn or subject to dirt, water or chemicals	Texaco Thuban 140 or Meropa Lubricant 6
Where surroundings are clean or chains are new or enclosed	Texaco Thuban 90 or Meropa Lubricant 3
C) Low operating temperature (0 to 32°F.)	Texaco Meropa Lubricant 1
3. Silent Chains	
A) Exposed chains	
a) Worn chains	
High operating temperature (Above 140°F.)	Texaco Thuban 140 or Meropa Lubricant 6
Medium operating temperature (32 to 140°F.)	Texaco Thuban 90 or Meropa Lubricant 3
Low operating temperature (0 to 32°F.)	Texaco Star Grease 1 or Multifak 2
b) New chains	
High operating temperature (Above 140°F.)	Texaco Thuban 90 or Meropa Lubricant 3
Medium operating temperature (32 to 140°F.)	Texaco Star Grease 1 or Multifak 2
Low operating temperature (0 to 32°F.)	Texaco Meropa Lubricant 1
B) Enclosed chains	
a) Bath lubricated	
High operating temperature (Above 140°F.)	Texaco Thuban 140 or Meropa Lubricant 6
Medium operating temperature (32 to 140°F.)	Texaco Thuban 90 or Meropa Lubricant 3
Low operating temperature (0 to 32°F.)	Texaco Meropa Lubricant 1
b) Force feed or splash lubricated	
High operating temperature (Above 140°F.)	Texaco Thuban 140 or Meropa Lubricant 6
Medium operating temperature (32 to 140°F.)	Texaco Thuban 90 or Meropa Lubricant 3
Low operating temperature (0 to 32°F.)	Texaco Meropa Lubricant 1

NOTES:

1) Wherever the chains of any type are to be used adjacent to *food handling and processing machinery* and where there is any possibility of the lubricant coming in contact with the foodstuffs or liquids being processed, consult with your Texaco Lubrication Engineer.

2) Where the chains are used on *bottling machinery* and there is any possibility of the lubricant coming in contact with the edible liquids being bottled, follow the same procedure as suggested in Note 1.

3) For chains used *inside ovens and* for *other high temperature conditions*, a comparatively low viscosity volatile petroleum product compounded with a high grade graphite has been successfully used.

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